

## TECHNICAL NOTES Surgical Site Infections in California Hospitals, 2014

### Introduction

These Technical Notes explain the methods used to collect and analyze data to produce the Surgical Site Infections (SSI) data displayed in the California Department of Public Health (CDPH) Healthcare Associated Infections (HAI) Program interactive map [1] and in the SSI tables for surgical procedures performed during 2014 [2]. Reporting of SSI data by California general acute care hospitals to CDPH and public reporting of hospitals' risk-adjusted SSI rates by CDPH's HAI Program were mandated by Health and Safety Code 1288.55 (a)(3), (b)(2), and (c)(1). The published SSI data tables present the complete mandated SSI reporting while the interactive map presents data for 10 of the surgical procedure categories defined by the Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN).

Since April 2011, California hospitals have been reporting SSI data through NHSN as specified by two, All Facilities Letters (AFL) [3, 4]. This report for 2014 is based on the third full year of SSI data on the 29 mandated NHSN-defined surgical procedure categories. Data were submitted via NHSN and CDPH accepted only SSI data for the surgical procedure categories that are in the hospital's NHSN monthly plan [5].

The frequency of SSIs varies depending on modifiable risk factors, such as surgical technique and infection prevention measures, and non-modifiable risk factors, such as underlying patient illnesses, whether the surgery was an emergency, and whether the wound was contaminated prior to surgery. The distribution of non-modifiable risk factors among patients, referred to as patient case mix, can vary widely among different hospitals. To report SSI rates that allow for meaningful comparisons between hospitals, it is critical to adjust for the differences in patient case mix. Instead of a risk-adjusted SSI rate, NHSN produces a standardized infection ratio (SIR) that compares the number of SSIs reported by a hospital to the number that is predicted based on a surgical procedure category-specific algorithm derived from national data reported to NHSN from 2006 through 2008. NHSN produces two SIRs for each surgical category, one that includes all SSIs (including superficial incisional) and the second, the Complex A/R SIR, that includes only deep incisional and organ/space SSI identified during the index hospital admission or on readmission to the same hospital that performed the inpatient surgery. For this report and interactive map, CDPH used only the Complex A/R SIR, hereafter referred to as SIR.

Ten surgical procedure categories were selected for presenting on the interactive map based on the number of SIRs generated. SIRs were generated more frequently for high volume surgical procedure categories, surgeries that have a higher predicted number of infections, or both. As such, these were the surgical procedure categories where infection prevention strategies would have the largest impact. These ten surgical procedure categories, abdominal hysterectomy, cesarean section, coronary artery bypass graft, colon surgery, hip prostheses, knee prostheses, open reduction of fracture, spinal fusion, small bowel surgery and bile duct, liver and pancreatic surgery, account for 66% of SIRs for all the risk-adjusted SP categories.

## **Methods**

### ***Reporting hospitals***

At the end of 2014, 392 California general acute care hospitals were enrolled in NHSN. Among these hospitals were long term acute care (LTAC) hospitals, rehabilitation hospitals and some specialty hospitals that do not perform surgeries at all or do not perform any of surgeries within the required 29 procedure categories.

In 2014, CDPH identified 392 licensed general acute care hospitals representing 419 physical campuses with active acute care beds that operated continuously (for the full 12 months) during the reporting period. Of these, 25 reporting entities had more than one campus associated with its license and 367 reported separately. In total, there were 392 reporting entities, hereafter referred to as hospitals.

Table A. General Acute Care Hospitals with Active Beds, 2014

	<b>Reporting Entities</b>	<b>Number of Campuses</b>
Hospitals that reported separately	367	367
Hospitals that reported together	25	52
<b>Total</b>	<b>392</b>	<b>419</b>

LTAC and rehabilitation hospital patients have clinically complex problems, such as multiple acute or chronic conditions and are admitted with an expectation that their hospitalization will be long. LTACs are defined by the Centers for Medicare and Medicaid Services (CMS) as a licensed general acute care hospital providing care for patients with medically complex conditions requiring an average length of stay for all patients of greater than 25 days. California LTAC hospitals were identified through CMS and assessments by HAI Program staff.

NHSN defines rehabilitation as evaluation and restoration of function to patients who have lost function due to acute or chronic pain, musculoskeletal problems, stroke, or catastrophic events resulting in complete or partial paralysis. Because the NHSN risk adjustment process was developed for general acute care hospitals and not LTACs and rehabilitation hospitals, the latter two are treated separately in this report in Table 30. No SSI information was reported by rehabilitation acute care hospitals.

### ***Data sources***

Hospitals enter surgical procedures into the NHSN database manually or electronically. They indicate which of the 29 surgical procedure categories they perform by entering them 'in plan' in NHSN. 'In plan' status means that the data will be incorporated into NHSN's national database and undergo some validity checking when entered. Reported surgical procedures that are not 'in plan' may be entered into NHSN with required information missing. CDPH classifies these procedures as incomplete and not included in our statistical analysis. A hospital specifies whether a surgical procedure category is 'in plan' every month. For the 2014 SSI tables, only data entered 'in-plan' are included.

All procedure and infection data entered before May 4, 2015 for surgical procedures performed between January 1 and December 31, 2014 were downloaded from NHSN on May 4, 2015 for producing this report. Information on the surgeries performed is entered separately from resulting SSIs. The surveillance period for SSIs is either 30 days i.e., colon surgery or 90 days hip prosthesis depending on the procedure type.

### **Definitions**

Hospitals report SSI data to CDPH through NHSN, which has specific protocols and definitions that should be followed when entering required information on surgical procedures and resulting infections. In order to implement the reporting mandate, CDPH uses the risk adjustment options available in NHSN.

- **Surgical procedure category (SP category)** refers to the relevant definitions for surgical procedures are the 29 surgical procedure categories listed in AFL-11-32 Attachment A. These are defined in the AFL attachment by reference to the NHSN list of International Classification of Diseases, 9th Revision Clinical Modifications (ICD-9-CM) for surgeries that make up each category that was current at the time of publication. NHSN updates the categories annually when ICD-9-CM codes may be reassigned to different NHSN categories [6].
- The **surgical procedure information** refers to the required information for each procedure and includes the patient's age, gender, weight, duration of surgery, closure, in- or outpatient, whether the procedure involved trauma, an emergency, whether the surgery was performed primarily using a scope or instrument able to visualize the interior of a body cavity or organ (for example, an endoscope or laparoscope), general anesthesia, wound class, and ASA Score. The latter two are categories created by the American College of Surgeons (wound class) and the American Society of Anesthesiologists score of general patient health (ASA). For a small subset of surgical procedure categories, more detail on the surgery is also required.
- The **wound class** categories are clean, clean contaminated, contaminated, and dirty. CDPH is mandated to report SSI rates for only clean and clean-contaminated wound classes consistent with NHSN risk adjustment methodology. The NHSN risk adjustment process includes adjustments for all wound classes, including contaminated and dirty in order to more fully characterize SSIs. Since limiting wound class reporting to clean and clean-contaminated would not allow complete risk adjustment, CDPH uses the current NHSN risk adjustment process that includes all categories.
- **Surgical closure** is defined as primary or non-primary closure. The primary closure is defined as closure of the skin level during the original surgery, regardless of the presence of wires, wicks, drains, or other devices or objects extruding through the incision. This category includes surgeries where the incision is closed at the skin level. Non primary closure was excluded from our analyses.
- **Surgical site infection specific events** are incisional infections that occur along the path of the surgical incision and are either superficial, involving skin only, or deep, involving tissue below the skin and either primary or secondary. Organ/space SSI

involves the organ(s) or internal area of the body that was the focus of the surgery. California mandated reporting includes deep incisional and organ/space SSI, but does not include superficial incisional infections.

SSIs are also categorized by the method used to detect them. The current categories of infection detection are while the patient is still admitted in the hospital at which the surgery was performed, upon readmission to either the same or a different hospital for treatment of the SSI, or using post-discharge surveillance methods outside of hospital admissions. CDPH includes in these reports only those SSI detected during the index hospital admission and upon re-admission to the index hospital.

### ***NHSN's risk adjustment method for SSI: The Standardized infection ratio (SIR)***

Information on each patient undergoing surgery is reported by hospitals to NHSN. NHSN statisticians used these data to develop mathematical models for risk adjusted expected infection counts. Risk adjusted SIR algorithms were developed for each surgical procedure category where there were adequate numbers of procedures and infections in the reference population (i.e., all SSI data submitted to NHSN from 2006 through 2008) [7].

When the observed infection count is equal to the expected infection count based on the national average, the SIR will be equal to 1.

The 'Complex A/R' model gives the expected infection count for inpatient procedures and primary, non-superficial infections that are detected upon admission or readmission to the same hospital. Procedures excluded from the Complex A/R SIR are those performed in an outpatient setting, with a duration that is excessively short or long, or information that is missing, or labeled as 'unknown'.

NHSN produces a risk-adjusted SIR, incorporating patient-specific information, for 24 of the 29 California required surgical procedure categories. For five categories, heart transplant, kidney surgery, ovarian surgery, pacemaker surgery and spleen surgery, there is a non-risk adjusted SIR based simply on the average of the reference population.

### ***Additional SIRs for hospital-specific SP categories with at least 100 procedures reported***

NHSN does not produce an SIR when the number of predicted SSI is less than 1.

"When the numExp is  $< 1$ , this indicates that the number of procedures performed is too low to calculate a precise SIR and comparative statistics" [8].

In 2014, 615 of 6596 (9%) of surgical procedure category entries had less than one SSI expected even though the hospital reported 100 or more procedures for that category. The patients undergoing surgery at these hospitals are considered to be at lower risk for SSIs than in hospitals with an NHSN-generated SIR.

In balancing CDPH's mandate to publicly report risk-adjusted SSI rates and NHSN's concern for statistical precision, the SSI data tables include an SIR computed from the observed number of SSIs and the NHSN-generated expected number of SSIs for those procedures where a hospital reported at least 100 procedures and there is no NHSN SIR because the expected number of

infections was less than one. These SIRs created at CDPH and their comparison results are marked in the tables with an asterisk (\*). They should be regarded as less precise and accurate than the SIRs calculated by NHSN where the expected number of SSIs is at least 1.

### ***Quality assurance and control***

Hospital personnel are solely responsible for the quality and completeness of their SSI data. The HAI program supported hospitals in establishing and developing their NHSN SSI reporting through trainings provided by regional infection preventionists (IP), training and reference materials on our website, email and phone access to the IPs, data managers and epidemiologists for assistance. In October and December 2013, and March and April 2014, the HAI Program sent quarterly QA/QC reports to all hospitals that included CDPH summaries and NHSN generated alerts for each surgical procedure category identifying missing or inconsistent SSI data that probably needed correcting.

### ***Validation***

In 2014, CDPH validation efforts helped hospitals assess and improve case-finding and evaluate completeness in identifying and reporting SSI. Smaller volume hospitals performed a self-review process using a validation workbook and reported results electronically to CDPH. In smaller volume hospitals, 39 out of 48 identified colon SSI were reported, for a sensitivity of 81% (67%, 91%). Validation at larger volume hospitals consisted of onsite visits by HAI Program Liaison Infection Preventionists. In larger volume hospitals, 204 out of 295 identified colon SSI were reported, for a sensitivity of 69% (64%, 74%).

### ***Data presentation and statistical analyses***

CDPH reports data on 29 surgical procedure categories: abdominal aortic aneurysm repair, appendix surgery, bile duct, liver or pancreatic surgery, cardiac surgery, coronary artery bypass graft with both chest and donor site incisions, coronary artery bypass graft with chest incision only, gallbladder surgery, colon surgery, Cesarean section, spinal fusion, open reduction of fracture, gastric surgery, hip prosthesis, heart transplant, abdominal hysterectomy, knee prosthesis, kidney transplant, laminectomy, liver transplant, kidney surgery, ovarian surgery, pacemaker surgery, rectal surgery, refusion of spine, small bowel surgery, spleen surgery, thoracic surgery, vaginal hysterectomy, and abdominal surgery.

We designated the infection count of a hospital for a surgical procedure category as higher (H), lower (L) or no different (N) than what was predicted based on the risk adjusted national average using the 95% confidence interval for the SIR, where computed. Since any statistic such as an SIR is an estimate of an underlying state, the confidence interval indicates a range of values for the actual SIR that could result in this SIR statistic, given random variation and the number of procedures performed. This means that an SIR 95% confidence interval that includes one indicates an observed number of infections for that hospital that is not truly different from the predicted number of infections based on the national average for that surgical category. Data are presented in 31 tables.

Tables 1 through 24 display data for each surgical procedure category, including hospital submitted procedure counts, infection counts, an SIR if computed by NHSN or CDPH, and the 95% confidence interval for the SIR. Based on the 95% confidence intervals, we labeled each

SIR as indicating either: N (no difference in number of observed and predicted infections), H (more infections than predicted), or L (fewer infections than predicted). Both the SIR and the comparison of SIRs calculated by CDPH are marked with an asterisk and a footnote to indicate that they are not to be regarded as equally reliable as the NHSN-computed SIRs based on a higher expected infection count.

Tables 25 through 29 display data for the surgical categories with non-risk adjusted SIRs, heart transplant, kidney surgery, ovarian surgery, pacemaker surgery and spleen surgery, are presented for each hospital. The reported procedure and infection counts are reported without any comparisons.

Table 30 lists the names of the two LTAC hospitals that performed some surgeries.

Table 31 lists 39 hospitals that submitted confirmation, either directly to CDPH or through NHSN, that no surgeries in the 29 surgical procedure categories were performed in 2014.

### **Limitations and Context**

NHSN requires that hospitals report only certain variables on each surgery. In deciding to include a required variable, NHSN staff weighs the relevance of the information against the required resources and effort for hospitals to correctly report it as well as reviewing recommendations from various governmental agencies.

One of the areas that can affect the SIRs in a systematically different way for different hospitals, biasing results, is the application of rules intended to make the comparisons fair. The exclusion of all infections detected through post discharge surveillance is based on the assumption that hospitals using this method will detect infections more thoroughly than hospitals using only admission and readmission for their surveillance. The percentage of infections detected using post discharge surveillance varies between hospital systems.

Starting with 2012 data, the Centers for Medicare and Medicaid Services (CMS) require hospitals participating in the CMS Hospital Inpatient Quality Reporting (IQR) Program to report on SSIs associated with abdominal hysterectomies and colon surgeries via NHSN. CMS is using a different algorithm than NHSN's to compute the SIRs that they display on their Hospital Compare website. The CMS SIR for these two surgical procedure categories includes all SSIs, including infections detected in post-discharge surveillance and readmissions to other facilities. CMS surgery reporting is limited to patients at least 18 years of age. CMS has the same 30 day surveillance period as NHSN, but uses only age and ASA score as risk factors to adjust their SIR. The NHSN Complex A/R SIR risk adjusts expected SSI counts for colon surgery by additional patient level factors of wound class, duration of surgery, use of endoscope and hospital size and medical school affiliation. For abdominal hysterectomy, the additional NHSN SIR risk-adjusting factors are surgery duration and hospital size. Both the number of SSI observed as well as the SIRs can differ between the CMS SSI reported data and the NHSN-generated data used by CDPH for this report.

## **References**

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